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A Half Century of Bacteriology.

PRESIDENTIAL ADDRESS, 1918.

FRANK ULYSSES GRANT AGRELIUS, President, 1917-'18.

Of all living things, those that are the smallest are probably the most important. This may not be literally true, but we venture the assertion that it is a close approximation to the truth. And we would venture another statement of about equal breadth: That the nation or people that acts in harmony with the most advanced knowledge of bacteriology will have a great advantage in the world; and that, on the other hand, the group that orders its affairs contrary to such wisdom is as certainly doomed to decline. It is partly because of this belief that I have chosen to discuss what I consider one of the most remarkable and at the same time a most encouraging record of man's achievement.

We know of no field of human endeavor in which the prophecy, "Ye shall know the truth, and the truth shall make you free," more aptly applies than in that of man and his relation to bacteria and other germs. For untold ages of time he had been enslaved by insidious enemies, scourged by tyrannical foes, thwarted again and again in his endeavors by forces more powerful than he. At the same time other myriads of beings were toiling industriously that soil might exist in which green plants could grow and furnish food for themselves and all other living things. Man now knows that countless tiny, but nevertheless powerful and harmful, germs are at all times ready to cause him suffering and often death, and that they are a real thing to be avoided, or their work counteracted. He also knows that probably many more germs are much more industriously toiling for him in many ways, and that without these latter he could not exist on the earth. Furthermore, and what is very important, he is learning that there are many ways in which he may avoid the possible harm from the one class, and that he may make even greater use of the other helpful class.

Another peculiar fact in connection with this science is that it has made practically its entire growth since that time, the fiftieth anniversary of which we celebrate in this session. Not only this, but very much of this development has been made in a much shorter period than fifty years.

One cannot take up a discussion such as this without seeing the rather odd fact that to one man alone it has come to lay by far the greater portion of the foundation of such an important science. The world is indebted to Louis Pasteur for a large proportion of the fundamental facts upon which the science of bacteriology rests, and through this such a far-reaching amelioration of conditions that it may well style him "The World's Helper."

Fifty years ago Pasteur had found the cause and cure of the two serious diseases of the silk worm and a cause of the souring of milk. He had done considerable work with the fermentation of various substances, showing that such changes were due to the activities of minute organisms. He had overthrown the doctrine of spontaneous generation as then understood. We should add, parenthetically, that Jenner had done an important act in discovering or applying properly the principle of smallpox vaccination. He had done this in 1798. But we will leave this, granting that much credit is due Jenner for it. From the observations of Pasteur mentioned there followed Lister's work which, when the Kansas Academy of Science was established, was largely in process of growth and demonstration. In 1867 he published a record of eleven cases of compound fracture treated antiseptically. We see then that this society is as old as antiseptic surgery. It follows that some of the fundamental facts of the science were known. However, the great mass of the discoveries of fact, and the invention and improvement in technique, were made well along in this period, and no small part has been accomplished within the last two decades.

We wish now to note another peculiar thing, and it is this: Man has often learned and made use of many practical facts when he had but a very imperfect knowledge of the fundamental principles in the case. We have referred to vaccination. This was practiced in England in the eighteenth century and probably long before this in China, but it was little understood. Jenner elaborated upon it, but it is not even now certain as to the real facts in the case. Man early learned also to be careful in the disposal of excreta, and with the bodies of dead animals. He was somewhat careful with his drinking water. He avoided the sick to some extent. He was even suspicious of the well from the point of view of his health. It has long been considered a deadly insult for one to spit upon another. Especially was it so regarded for one to do this in the other's face. It is reasonable to suppose that this may have come about from a slowly developed intuition of the possibility of contagion in such cases. Most boys have been cautioned not to lie around sluggish streams in the heat of the summer, and most of us have been told of the dangers of night air.

We should not wonder at these vague notions, especially when we consider the great difficulty of knowing and understanding organisms as small as many germs. Pasteur accomplished his early work by the aid of the compound microscope. There are even now many difficulties in the way of one who would study bacteria.

But to take up the main thread again. In 1876 Koch proved that anthrax in cattle is caused by a specific germ—*Bacterium anthracis.* He also advanced his rules of procedure in determining the cause of any germ disease. These are "Koch's laws": (1) The germ must be found present in the typical disease. (2) It must be isolated and grown in pure culture. (3) It must produce when introduced in pure culture into the body of the normal animal or plant the typical disease. (4) It must again be isolated from the diseased organism. These laws have been rather closely observed, and show with what care science advances before pronouncing any dictum.

But to follow these laws is easier said than done. It is often not easy to isolate an unknown germ. It is very difficult even to find them sometimes. and it is quite probable that some are still invisible. Paul

Ehrlich has done much in the discovery and application of stains. Others of course have helped. Staining, especially when differential or contrasting so that the bacterium will be differently colored from its surroundings, has enabled experimenters to see germs where they would otherwise have been invisible.

Koch himself performed a strictly fundamental thing when he invented the use of gelatine as a part of media. This rendered rather easily possible in many cases the isolation of a pure culture by entrapping the germs, and requiring them to develop at points isolated from one another. Other media having a similar purpose are now made. Our own Professor Barber went a step farther and to a nicer conclusion in making possible the isolation of a single germ by his method of the very small pointed capillary pipette. It may interest some to know that Professor Koch did not have much faith in Professor Barber's device until he was shown it in use. Then he gracefully acknowledged his sin of unbelief and atoned by ordering some of the improved apparatus.

Many different practices are now followed in obtaining pure cultures. These include animal inoculation where, in specific cases, the animal will destroy all but the one kind of germ and it will then be found in pure culture in some part of the animal body. Other methods have for their purpose the same end through a gradual elimination of those germs not wanted and of the enrichment of the culture in the one desired, as in the use of malachite green-agar by Löffler to secure typhoid germs. Then there are differential media, such as Endo's, for the differentiation of *B. typhosus* from *B. coli.*

However, isolation is not the whole matter. It is often very difficult to make bacteria grow at all, and a vast amount of study and experimentation has resulted in a very great variety of media and of much better understanding of the nature of bacteria and of the food requirements of various kinds. It may be noted that the requirement varies from the purely mineral to practically a need for the living protoplasm of some very closely limited species of plants or animals.

And after recognizing the task assumed in applying the first two of Koch's laws we are still not through with our difficulties. Often a germ is harmless to an animal unless some peculiar method of inoculation is used or some more or less exceptional condition of the animal is to be induced. Tetanus germs are ordinarily harmless when taken into the stomach, and again they may prove harmless when placed in the flesh in pure culture. When accompanied by ærobes in the latter plan they are much more serious. Typhoid bacteria fed to one person could easily cause typhoid fever, but in one who for any reason is immune to it they would produce no noticeable effect. Koch's laws are good laws, but their demonstration is often very difficult, and still the undoubted causes of many diseases have been proved and these laws yet observed.

The use of gelatine media was announced in 1882. In May, 1881, another milestone in this science had been reached. Pasteur, working near Melun, France, inoculated fifty sheep (really some were goats) with virulent anthrax germs. He had protected twenty-five with attenuated anthrax bacteria, but had left the others unprotected. It was a case of Elijah and the priests of Baal, for here he was to demonstrate to many disbelieving scientists and others his claims regarding a matter of truth and falsity. The figure could be carried further. On the second day following a great crowd was present. Twenty-two of the unprotected animals were dead, two were dying, one was sickening. All of the twenty-five protected ones were in good health. This one practice, demonstrated here, has saved France many millions of dollars annually. But what is more important, it laid the foundation for an immense amount of investigation of the whole question of immunization against disease.

Probably next to that of Pasteur, Paul Ehrlich has done more to explain the mechanism of immunity than any other man. In the later years of the last century (1897) he advanced what is known as "Ehrlich's Receptor Theory." This asserts that cells are able to utilize the food substances present in the blood by means of certain attributes similar to the "side chains" of the "benzine ring." When for any reason these side chains, or cell-receptors, are destroyed, but the cell not killed, there is an overproduction of receptors, and these, cast off into the blood, are the antitoxins and other antibodies often found in the animal body. Whether true or not this idea has been very fruitful in explaining many cases of immunity, and in suggesting proper lines of procedure for further attempts at immunization. Of these more later.

Metchnikoff advanced the so-called "phagocyte theory," and to Wright is due the greater credit for the application of this theory in his work on the "opsonic index." This theory often explains the presence or absence of immunity, and its loss or acquirement, as for instance in tuberculosis. It throws light on the question of the crises that occur in diseases, and often is a guide to the physician in his treatment of various ailments.

The discovery of the precipitins formed by bacterial action has given man a fine instrument to assist him in determining relationships between animals, and also enables the law to pronounce accurate judgment upon the testimony of persons concerning the source of blood stains and meat products. These and other matters of technique are modern parallels of Solomon's wisdom in using the bees in distinguishing between the real and the artificial flowers.

Through the principle of complement fixation it is now possible to determine with considerable certainty whether one is or has been the carrier of *Treponema pallidum*, the cause of syphilis, and through the agglutinins it can be determined whether one is or has been recently affected by *B. typhosus*—the "Widall reaction." Of course this is not all of the ways in which these specific discoveries can be and are applied, but are simply illustrations.

The peculiar phenomenon known as "Anaphylaxis," or protein sensitization furnishes an explanation of the effect of typhoid bacteria upon the body, and of immunization acquired by typho-bacterin treatment. It also explains immunization by vaccination as in smallpox. The body produces an antibody—an antienzyme—for certain proteins present in the typhoid bacili, and in the organism or whatever it may be that causes smallpox.

The technique and subject matter of the science has now become so broad and complicated that in it, as in many other sciences, it is necessary to specialize along many different lines, and of course there is no probability that the end is near.

The influence of the science is now felt in numerous paths of activity, and naturally it invokes the aid of many other branches of learning. Its greatest influence is probably exerted in medicine, but it likewise furnishes much of the subject matter in other professions or occupations. Only a few of these will be named.

In agriculture we see that the richness of the soil is due to the decay of organic substances, and that this is brought about in the main by bacteria. We know that the destruction of these things is often decidedly unwelcome, but it is, nevertheless, a beneficent and entirely necessary process. Otherwise the needful elements, such as nitrogen, stored up in the bodies of plants and animals, would very tardily be again available for our use. Nature would then be a genuine miser, taking the necessary elements of life and activity out of circulation. It is thus seen that our very life is dependent upon death and decay. Again, bacteria add nitrogen to the soil from the great ocean of it in the air. Others help to render certain substances available for plants. Sulphur, phosphorus and others are included in this list. But others, like the Prodigal Son, are ready to waste the needful substances of the soil, and will do so if not controlled. These facts added to others, such as the loss of living plants and animals and various farm products, bring the farmer face to face with the necessity of an understanding of bacteria.

This leads us to a realization of the fact that man from time immemorial has had to struggle to keep foods obtained in excess of need at certain times or places to the time or place in which the order of need and acquirement shall have changed places. Bacteria of decay have largely been the occasion of this, and our great canning and other food-preserving industries are the result. It is quite evident that man was intended to live by the sweat, not only of his brow, but of his intellect as well.

We are led further again, this time to see a connection between bacteriology and commerce. The thousands of refrigerator cars will illustrate our point. Quarantine regulations against bubonic plague and Texas fever are others. Our experience with foot-and-mouth disease is quite fresh in memory.

The principles of bacteriology have had a great influence on hygiene and sanitation, and these subjects consist largely now of rules, the need for which was made apparent by the facts of this science. These again ramify through all of the avenues of life. They may be said to reach from one extreme to another—all the way from the drainage of land, the construction of buildings of all sorts, to the sentiments expressed in kissing. They range from table etiquette to the disposal of sewage; from even before the birth of a child to the disposal of the body after death. Further mention will be made in a consideration of specific disease to follow later.

In contending with diseases caused by germs several matters are of prime importance. Among these are the discovery of the causal microbe, its isolation, a study of its growth and physiological characteristics, its distribution in nature, the modes of infection, and the means of immunization against it. The more completely these factors are known, the more effectually we may control it. Truly marvelous results have been accomplished. It should be noted here that "Peace hath her victories no less renowned than those of War," and that these are often bought for a price as in war. More than one person has risked and even lost his life voluntarily in this line. The number of lower animals that have been sacrificed is legion.

The means of combating smallpox have long been known. When applied the results have proved their efficiency. In Germany since 1874 all infants must be vaccinated during their first year, and again at the age of twelve. Since that date long periods have passed without any deaths in the empire, and this with a constant introduction of the disease from without. In the German army up until recently there have been only two deaths from this disease since 1874. One of these was a reservist who had not been successfully vaccinated. Contrast this with the following. It is estimated that fifteen million people died of smallpox in twenty-five years in the eighteenth century, and that sixty million people died during the whole century from that disease. It was brought here from Europe about fifteen years after Columbus discovered America. An authority estimates that six million Indians died as a result out of a population of twelve million. In 1707, Iceland lost 36 per cent of its population from this disease. Its teeth have not been pulled yet in all countries. Russia lost 275,502 in five years from 1893 to 1897. These figures are far more hopeful along bacteriological lines than along sociological ones.

Quite a similar story may be told of the awful disease, hydrophobia. Through the knowledge of the use of an attenuated virus from the spinal cord of the rabbit, Pasteur has given us an efficient method of procedure after possible infection. The results of this treatment at the Pasteur Institute in Paris from 1886 to 1914 range from .94 per cent to .00 per cent of fatalities among the cases treated. There were no deaths in the last 1098 cases. This contrasts favorably with the rate of 6.6 to 10, and sometimes 16.6 per cent among all persons bitten by rabid animals (dogs). A remarkable illustration of preventive methods is found in the case of Great Britain. Beginning with 1887, the muzzling of dogs was made obligatory, with the following results: 217, 160, 312, 129, 79, 38 cases of hydrophobia. Then the muzzling was relaxed out of sympathy for the dogs, and there followed: 1893, 93, 248, 672 cases. Then the law was again enforced. In 1896, 438 cases. Then these: 151, 17, 9, 6, 1, 13; and none from 1903 until 1906, when this record closed.

The part the tonsils have to play in infection is much discussed. Their relation to a form of rheumatism came under my observation in one case. A prominent man in one of our state institutions was a sufferer from this disease. It had well-nigh caused him to give up his work when he was induced to have his tonsils removed. A rather severe infection of the lacerated surface followed unfortunately, and he suffered another severe attack of rheumatism, worse than ordinary. The infection soon ceased, he recovered at once from the rheumatism, and up until recently during a period of several years, he has not had a single recurrence of his former malady. Other forms of rheumatism respond less favorably.

Many cases of appendicitis are now successfully treated when before our period they were probably unrecognized, or would have been disastrous without antiseptic and aseptic measures.

Diphtheria is of especial interest because of the discovery of diphtheria antitoxin by Behring and Kitasato in 1890. They found that the toxin produced by *Mycobacterium diphtheriæ* provokes the production in the animal body of a substance that will neutralize the free toxin either within or outside of the animal. Its action is not upon the germ but upon the toxin produced by it. Because the horse is found more suitable than other animals for the purpose, it is used for the preparation of diphtheria antitoxin. This is largely because of the large amount of blood that may be withdrawn without serious harm to the animal. At the present it is often purified and concentrated, is then standardized by the use of a government standard unit, tested ærobically and anærobically, including animal reactions for its bacterial purity, placed in the proper receptacles, and is ready for use. It has robbed this dread disease of many of its terrors, and if administered in time (during the first twenty-four hours of the disease) the mortality is practically none. In cases taken as they run in ten states and cities of the United States the fatalities in the decade ending with 1914 ranged from 9.67 per 100 in Michigan to 3.09 per 100 in Newark, N. J. 0.001 cc. of filtered broth culture of this germ has been known to kill a guinea-pig. This is an extreme case, but it illustrates with what man has had to contend in fighting this disease.

Schick has devised a test for the presence or lack of immunity in a person. On injecting one-fiftieth of a minimal lethal dose for a 250 gram guinea-pig into the skin of a person, if there is no local reaction, the person is immune. If there is a white spot at the point of reaction, with a reddened area around it, then there is no antitoxin present in the blood and the person is not immune. Through this test it is quite possible to discover just whom to treat or not in an epidemic. It is supposed to act on the same principle as the tuberculin reaction in tuberculosis.

Among the common diseases of man malaria is one of the most interesting. An historical account of it with the steps taken to come to a definite understanding of its etiology, the modes of its transference, the means of its prevention, etc., reads like a fairy tale. It has long been known. It has probably been one of the causes of the non-development or decay of nations or peoples. Some have thought that Paul's "thorn in the flesh" may have been this disease, contracted in the marshy districts of Asia Minor. It probably accounts for the fear of "night air" so common in our childhood. The transformation of the causal parasite, the peculiar disparity between the hosts, the life-cycle and habits of the mosquito, and the consequent means of prophylaxis are all rather complicated and remarkable. Laveran discovered the parasite in 1880, and Ross startled science by announcing his methods and the method of its transmission in 1895. The seeming fact that but one genus of the mosquito, *Anopheles*, can act as the alternate host with man is a peculiar circumstance. We here see well illustrated the fact that seemingly unrelated data in pure science may prove of the greatest practical value when coupled with other data. Knowing the life history of the mosquito and its connection with the disease, one method of attack is readily seen. As far as possible, prevent the breeding of mosquitoes, keep them away from the sick and from the well. This mosquito breeds in ponds, or quiet water. Its larvæ breathe through spiracles. Oil will form a thin film upon water. Then drain pools, oil the pools not drainable, screen the barrels. These lessen the numbers of mosquitoes. Screen the home with a fine-mesh netting. Be especially mindful of the sick. Let people stay within doors, particularly at night. This tends to lessen the infection of the insect and also of man. Then it has also been discovered that quinine is a specific in malaria. Take it in proper doses during the dangerous seasons. Some very dangerous localities have been much improved by these practices.

Yellow fever is quite similar to malaria in many ways. It is, however, much more fatal, but fortunately also more limited in its habitat. But one mosquito, *Stegomyia calopus*, can carry the infection, another fortunate circumstance. A person infected cannot infect the mosquito after the third day of the fever, nor can the mosquito infect people until about the twelfth day after drinking infected blood. Most of the above-mentioned facts were learned through the work of four medical officers of the United States army (1900-1902). Of these Lazear lost his life in submitting to experiment, but thereby proved his point. This is another illustration of the cost of some bacteriological facts now of such helpfulness to mankind. In this instance we again see a fine illustration of the extreme practicability of the seemingly impractical pure sciences. I have read that when the Panama railroad was built a life was sacrificed to disease, at that time unpreventable, for every tie laid, a fearful price to pay to ignorance. General Gorgas, having the knowledge necessary, built the Panama canal with but little loss of life from infectious or other disease. The story of this and other triumphs of modern science should be pasted in the hat of every legislator. Knowledge is power! We wish to stop here to voice the prayer that sociology might keep pace with science.

The cause of "sleeping sickness," *Trypanosoma gambiense*, was discovered by Dutton in 1901. Its causal relation was shown by Castellane in 1903. Between 400,000 and 500,000 deaths resulted from this disease in the Congo region alone between 1896 and 1906. The parasite is transmitted to man by a fly, *Glossina palpalis*. According to Rosenau, few, if any, cases ever recover. Jordan says that it is invariably fatal to man. Ehrlich worked hard to conquer it and did produce a drug, atoxyl, which gave some hope of success. Some of the trypanosomes became immune to the drug, however, and so the purpose of the treatment is thwarted. The most hope at present seems to lie in preventive measures such as isolation of the sick. The outlook on the whole seems discouraging. We are all familiar with recent developments in the bubonic plague. It has come too close for comfort, being fairly well established in California. We know too of the rat-proofing of New Orleans, and of the amount of work and heavy expense incident to such a heroic measure. It is well to bestir ourselves. The "black death" claimed twenty-five million people in 1348-1349. From 1898 to 1907 it caused about six million deaths in British India. We all probably remember the epidemic of the pneumonic type of this disease in Manchuria in 1910 and 1911. The mortality there was over 90 per cent. The transmission of the ordinary type by the flea, aided by rats, was demonstrated early in the century, 1906 and on. Again one of our number, Professor Barber, is quoted as an authority in a report made while he was in the Philippines (Tropical Medicine, 1913, VIII, 241). Through preventive measures such as the destruction of rodents, etc., and the use of Haffkine's prophylactic, there is a possibility of control. Haffkine's treatment is estimated to reduce the chances of infection four-fifths and increase the chances of recovery two and one-half times.

Again we are probably very familiar with tuberculosis, the great white plague, its occurrence, effects, treatment, etc. We may not know that the deaths from it in Massachusetts declined from 500 per 100,000 in 1855 to about 210 in 1906. The tubercle germ was discovered in 1882 and much work has been done with it since, especially by Robert Koch. The germ has been demonstrated in nearly every organ of the body. It is fairly certain that most people are, or have at some time been, infected. From this we see that methods of attacking it should be largely the building up of the resisting powers of the body and thus prevent its encroachment upon the unaffected tissue. Early diagnosis also helps. Sanatoria, where the sick may receive proper treatment while uninfected dependents are cared for at home, are being erected by some states and other institutions. The state can well afford this if any appreciable amelioration results. It is estimated that tuberculosis costs the United States from 150 million to 200 million dollars annually in money. In 1900 it caused about one-ninth of all deaths. Infection by man from the bovine type is supposed to be higher in children and nearly negligible in adults.

Leprosy has, like tuberculosis, been long known among men. It was quite prevalent in Bible times. The present situation is quite hopeful. Treatment is limited largely to isolation and betterment of living conditions about as in tuberculosis. Cures are probably rare. By mild rules of segregation Norway has reduced the number of cases from 2,870 in 1856 to 577 in 1900. Like many other diseases it can probably be readily stamped out through the application of known principles of procedure.

The great mortality among infants during the hotter months has long been noted. Much has been done to lessen this through the observance of bacteriological principles. Attention to the source and care, and especially the prevention of contamination of the food and drink of the child, have been some of the main measures. The partial elimination of the house fly is a probable factor.

But to limit this address we shall next consider as briefly as we well can the part this science has had in the present world catastrophe. It is indeed an ill wind that blows no good. The desperate need of protective and curative bacteriological practices; the large number of the world's best bacteriologists and other scientists who have turned their greatest efforts along these lines, and the vast amount of clinical material upon which to practice, have resulted in great advances that shall prove blessings of the highest order to mankind for many years to come.

The definite cause of typhus fever has probably been isolated and a severe epidemic in Serbia was put down by Dr. Strong and his helpers. This is a bright page in the war. Cerebrospinal fever, or meningitis, has been largely mastered through treatment, and through prevention, by the discovery of and isolation of carriers. The struggle with pneumonia has not been as encouraging, although the situation is fairly well in hand in the army cantonments. Trench fever has appeared. It is never fatal, but is very painful and lowers the efficiency of the troops considerably. But little other than the symptoms is known about it. The cause seems to be in the red blood corpuscles, but no germ has been reported at this writing. There is much speculation as to its origin. It has probably been introduced by some of the soldiers from the widely scattered regions from which troops have come. It is presumed that lice have something to do in its transmission from the sick to the well.

Gonorrhea and syphilis have received a great amount of attention both in this country and abroad. Serious conditions have been reported both in our cantonments and at the various fighting fronts. The peril to future generations is great unless some radical improvement in conditions is brought about. Conditions in France have been aggravated by the fact that large numbers of women have been rendered dependent by the exigencies of the war. American soldiers abroad are particularly endangered through the fact that they receive by far the largest pay of any of the soldiers fighting there. A startling announcement was made from Philadelphia recently. Dr. Simon Flexner claims to have found a new cure for syphilis, "A, 189," an improvement over salvarsan. It is reported to cost six cents per dose, while the latter is quoted at three dollars for a similar amount. At the same time Dr. Mentzler, also of the Rockefeller Institute, announced a new cure for tetanus. It contains magnesium sulphate. The number of cases of lockjaw have already been greatly reduced, that is, from thirty-two per thousand of wounded to two or less per thousand. This has been brought about through the protective inoculation of every wounded soldier with tetanus antitoxin as soon as possible ofter receiving the wound. This does not shed any light on the magnesium sulphate method. I found no data upon it. "Gas gangrene" from *B. welchii* has been very prevalent and dangerous. This follows from the fighting in the mud and wound contamination from the infected soil. The bombing of the allies' hospitals by the Germans apparently had this largely in mind, as wounds are much more serious, especially from this infection, if not given attention within a few hours. Curative measures have been devised, but their success is not yet determined.

Infectious jaundice has been abundant, especially in Italy. It is presumed to be caused by a Spirochæte, *S. ictero-hæmorrhagiæ.* The Japanese have discovered that this parasite is common in wild rats. The fact that the trenches are badly infested with rats lends color to the above conclusion. Cholera appeared on the eastern front. However, knowing that it is transmitted in food and drink, especially in water, enabled the authorities soon to bring it under control. The results have not been serious, considering this disease. Treatment similar to that of typhoid helped to hold it in check. In former times the story would probably have been very different.

Amœbic dysentery has caused trouble, but has been pretty well controlled by "emetin," and by using sanitary precautions. Bacillary dysentery has been reached practically only by proper sanitation.

Among all of the diseases prevalent in armies, typhoid fever has long been the worst. Its reign, however, has been too autocratic, and it now has gone to join the already large company of the dethroned, the number of which we hope soon to see augmented. In the Franco-Prussian war, sixty per cent of the mortality in the German army was from this alone. In the Boer war the British had 31,000 cases of typhoid and 5,877 deaths. In the Spanish-American war, out of 107,973 men there were 20,738 cases, 1,580 deaths. One case to every five men, nearly. In contrast there were, in 1911, 12,800 men in the camp near San Antonio, Tex., for about four months. These had all been treated with "Typhobacterin." There was but one case, that of a teamster who had not completed his inoculation, and his case was a mild one. One of my pupils was on the ground and was familiar with the situation. There was plenty of chance for infection in the near-by city to which the soldiers had the customary access. In the present war millions have been treated, ninety-seven per cent of the British army. The death rate in the British army among the treated has been 1/65th of that among the untreated. They are now killing three or more birds with one stone by including in the treatment Paratyphoid A, and B, and sometimes the cholera germs. They are thus disposing of all of these mischief-makers at once. What a record this is!

The general subject of wound infection has been a very important one. Great advances have been made in the three or more years of the war. Methods of antisepsis have enabled surgeons to perform startlingly complex but successful operations resulting in the restoration to somewhat normal conditions of the badly disfigured or mutilated. In former years this would not have been possible. Two general methods of wound treatment are practised. Wright uses a strong saline solution or even a salt pack. The object is to increase phagocytosis and may be called a physiological method. Carrel has used continuous irrigation with a modified hypochlorous solution. The agents used are chosen because of their selective or discriminatory action, harming the germs while not damaging the tissues. This is an antiseptic method. *Chloramin-T* is another substance much used, and still another that is highly praised in *fluvine,* prepared by Ehrlich some years back for use in sleeping sickness. It has cleared up septic cases of months' duration in a few days. And the end is not yet!

To summarize the situation in the war from our point of view we can well use the following clipping copied from the Emporia *Gazette* of December 27, 1917:

> "FIGHT GERMANS AND LIVE.
>
> "New York, Dec. 27.—Fritz-fighting adds five years to your life and has its merits in several other ways, according to late Canadian statistics. Here are some of the chances your boy will take if he goes to the front:
>
> "He has twenty-nine chances of coming home to one of being killed.
>
> "He has ninety-eight chances of recovering from a wound to two of dying.
>
> "He has only one chance in 500 of losing a limb.
>
> "He will live five years longer because of the physical training.
>
> "He will be freer from disease in the army than in private life.
>
> "He has better medical care at the front than at home.
>
> "Only ten per cent of the men disabled for further military service have been unfit to resume their former occupations.
>
> "Less men die of disease than in any war in history."

I think that all will agree that much of this is true because of the present situation in bacteriology. Nor would we in any way wish to detract from the honor due other sciences that have aided in this work. However, our science has not been prostitute in any great degree to wrong uses, as may be said of some others. Its services have been entirely beneficent, restorative, constructive. This is as it should be.

In conclusion, we would add that very much more could be said in such a review. We have scarcely mentioned several great phases of the subject. The members of the Academy have largely witnessed the entire development of this great science, and if a single half century can accomplish so much, what may we not look for in the future, and probably the near future at that!

We would close, as we began, by prophesying that the individual, and especially the people who would thrive and succeed in the race of life, must be cognizant of the principles and practices of the science of bacteriology.

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